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The Research of Petroleum Enterprise Information System Architecture Based on the G/S Model

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Abstract

This paper explains the petroleum engineering technologies of petroleum enterprise supported by G/S model, which combine process of exploring, developing, and transporting of petroleum enterprise, these key technologies with spatial information technology supported by Digital Earth Platform, resulting in the improvement of the scientificity, accuracy, and rationality of the petroleum engineering technologies and the reduction of the cost and the increase of the benefits.

Keywords:G/S model, digital earth platform, petroleum enterprise, information system architecture

1. Introduction

In the long-term petroleum exploration, the various petroleum field units accumulated the massive petroleum exploration achievement and information. This exploration information is the fruit gathering sedulity and wisdom by several generation of petroleum geological practitioner; it is also the national precious wealth and the important basic information resource for the national economy construction and development in petroleum field. Since long ago the information disperse at each specialized department (company) in petroleum field, it carries on the management separately by each specialized department. The sole storage means, the paper medium storage and the inefficient manual management etc., are still long-standing in the aspects of storage and development-utilization at present. The kind of condition is radically unable to satisfy the demand of management for the geological information in the age of 21st century. It is really urgent to carry out the information-based management for geological information.

G/S(Geo-Browser/Server) model is a new concept refining from the Digital Earth Platform, Its the new way to establish the high-resolution remote sensing images and other spatial data in a uniform coordinate

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projection system as a framework, an open XML standard for data exchange, spatial data conversion to support, 3D visualization technology and distributed network to connect geospatial databases. Its functions constitute of spatial data storage, transmission, conversion, processing, analysis, search, expression, output for other software. Digital Earth Platform is a computer-aided decision-making system. It is an import product of Earth Science research on the history of digital earth processing and a great achievement of spatial information technology development. So take advantage of Digital Earth Platform to study the petroleum resources exploration, development, gathering and transportation projects and techniques is necessary and feasible, effective.

2. Content of G/S Model

2.1 Concept of Digital Earth Platform

In 1998, American former Vice President Gore proposed the construction plan of digital earth, he also has foreseen the magnificent perspective which digital earth can bring. On the base of it, the science project and powerful measure which can settle the issues of resource and environment are presented. This plan immediately made tremendous convulsion in the academe and the political circles all over the world, it has started a globality upsurge of digital earth to construct digitization homeland.

The digital earth platform is generated when the researching of digital earth run to a certain phase. It programs the correlative work for the acquirement, transaction and application for the digital information of the earth surface layer and shallow surface layer in a long-term period, it also combines the existing and developing the theory, technology, data, application and capability which are correlative with digital earth from the standpoint of system theory and integration. It It should be an open and sharing computer aided decision-making system, bearing the characteristics of the earth's spatial data collection, storage, transmission, conversion, processing, analysis, searching, expression and output as a unified body and taking the spatial image data of high resolution as a base, the unified coordinate system as a framework, the open XML as a standard for data exchange, the infrastructure of spatial data as a mainstay, the 3D visual system as a method and the distribution network as a link.

2.2 Concept of G/S Model

With the rapid development of the IT technology and the spatial data acquisition technology, multi-source, multi-resolution, multi-temporal global earth observation data sets are produced, including satellite and aerial imagery, 3D models of terrain and buildings, text, maps, images, 3D models, multi-media data. For this reason, the representation of spatial information should rely on the vector or raser graphics and combine with the vivid express way of image, text, sound and video, and thus finishing the data display, sharing and interoperability.

G/S model is the browser/server system that is able to browse, manipulate and analyse the geoscience information under the internet environment. Only the browser indicates the Geo-information Browser (shortened as G), and the server indicates the spatial information server(shortened as S). Taking the spatial information interchange system which is standard, open, supported widely and based on XML, namely HGML(Hyper Geographic Markup Language)as the foundation, G/S model is able to implement the organization, management and exchange of the spatial information under the distributed network environment.

The geo-browser not only provides the text, picture and multi-media information browsing service that is supported by the Web browser, but also displays and describes the spatial information in term of the geographic location. Furthermore, geo-browser supports such functions as the vector data modeling,

various search and inquiry mode based on content or spatial position, spatial analysis, 3D virtual environment and scenes navigation, and according to the prompt it can save the visited content and implement once download for multi-utilization of the vector and raster data.

The spatial information server is the distributed server group, which is mainly responsible for the storage, processing and update of the massive spatial information involved in vector data, raster data, 3D model data and the other related text and multimedia information.

3. Petroleum Enterprise Information System Architecture Based On G/S Model

The architecture of the G/S model is the distributed network structure system under the internet environment based on the geographic information exchange standard—HGML which aims to build on XML-based standard. It mainly includes two parts: geo-browser and spatial information server. The geo-browser may be mobile terminal, computer terminalor the other special terminal (e.g. digital guide device). The spatial information server is functionally divided into two kinds: the basic spatial data server which is used to organize and manage the remote sensing data, the navigation satellite data and the terrain data; the industry application data server which is used to organize the thematic data related to the different industries or professionals such as surveying and mapping data, geological data, geophysical data, ecological data, tourism data, traffic data, forestry data, agricultural data. The architecture of the G/S model diagram is shown in Figure.1.

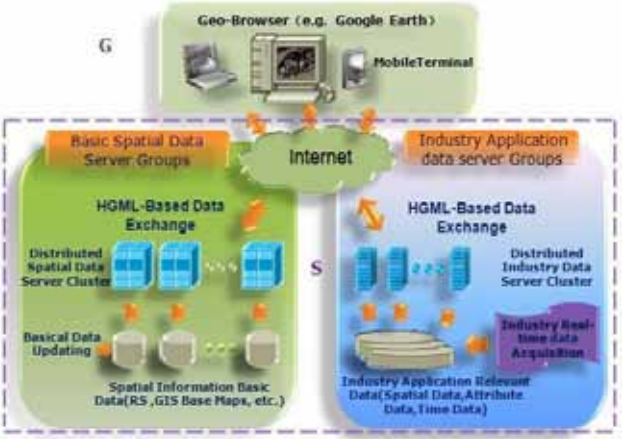


Figure 1. The architecture of the G/S model diagram

3.1 The petroleum exploring based on G/S model

The ideal petroleum exploration method both can discover the structure and point out the position of petroleum pool. It might reduce the risk, save time and expense in this way. The existing exploration method can be divided into two kinds: (1) the method for structure detecting, such as earthquake, gravity and remote sensing. (2) The method for petroleum inspecting, such as surface geochemistry, well searches, petroleum well logging and the remote sensing.

The petroleum bearing basin in structure is easy to trap petroleum; therefore it must seek the structure. The satellite imagery and the aerial photograph can discover the structure effectively. In the petroleum geology research and the exploration domain, the petroleum remote sensing institute has successively carried out the remote sensing geology research in Talimu, Sichuan, the area south of Yellow River, Chaidamu, east of Hebei Province, small basins in 14 provinces in South etc., the remote sensing

geotectonic research and the petroleum resource appraisal which proceeded in Northeast rift valley and Baise basin have provided the important reference for the petroleum exploration. The Qinghai-Tibet Plateau remote sensing petroleum geology route investigation and the remote sensing geology mapping which developed in1994-1998, has completed the nation large-scale petroleum basin petroleum remote sensing exploration research. The petroleum remote sensing information integration applied researches completed the Erdos basin in Loess Plateau area in 2000-2002; it has predicted the exploration target area successfully.

The geo-browser takes the high-resolution satellite images as the foundation, seamless splicing technique causes the images to be continual, high accuracy DEM in shooting adjustment cause the space position to be accurate; it can see the multi-styles surface about positive structure and linear structure on the platform, withdrawing this structure information effectively and accurately. Satellite remote sensing data shows many signs for exploration of petroleum and gas on the surface, which is a direct means to be an irreplaceable role for petroleum exploration. The result of the petroleum micro percolation causes the surface of spetroleum or the rock to get geochemistry alteration; which have the high spectral response on the multi-spectrum remote sensing image. Such as hydrocarbon's fading altered (In hydrocarbon spetroleum or rock, the content of Fe2+ increase and the content Fe3+ lower) and rock's mineralization.

Taking advantage of remote sensing images of geo-browser can not only macroscopically study regional distribution of petroleum and gas resources, re-locate and understand structural pattern , but also process remote sensing images and analysis the geologic structural distribution of microcosmic features, such as image processing to get the distribution of hydrocarbon and analyzed spectral reflectance anomaly region, which provides a good basis for researching evolution and field validation.

Petroleum exploration and development techniques make progress rapidly; quite more commonly used method is seismic, gravity exploration, magnetic exploration, and electric exploration. These data which should be organically integrated and certificated can be good reference for petroleum and gas data interpretation(figure 2). Digital Earth Platform which GIS system be supported with spatial information, can effectively organize and show the petroleum data. On the base of it, to select the best road for field project and optimize surface geological survey and surface geological modeling, to consist of optimization of system design and acquisition program, monitoring the quality of the construction field exploration and estimated acquisition project budget, optimization of the organizational and logistical support and routes etc., all are available. On Digital Earth Platform, to develop a production information system which relates to drilling, logging, seismic exploration, non-seismic exploration testing petroleum exploration, testing mining and other information; also relates to the integrated research results of petroleum and geology such as the areal geology, the structure regionalization, the sedimentation paleogeography, the petroleum pool and the reserves distribution, the petroleum gas resources potential appraisal and the spreading of hydrocarbon reservoir covering strata etc. It still involves the status of geography and ground surface including geography location, height above sea level, physiognomy, transportation, hydrology and anthropogeography etc. The above system may realize the petroleum exploration information integration, the visualization synthesis management and application, and support fast and scientific petroleum production decision

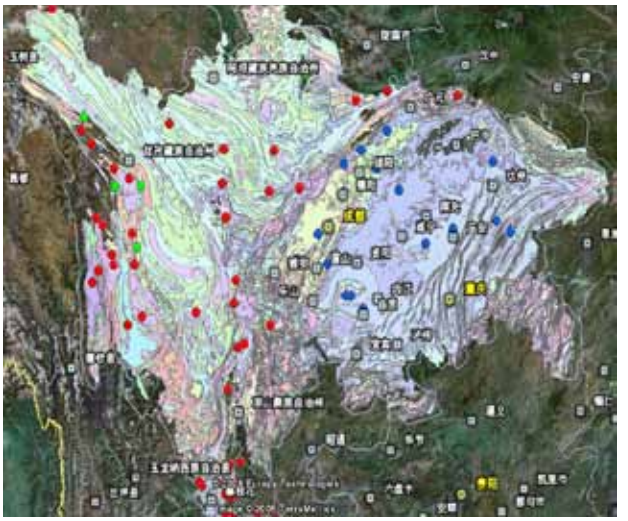


Figure 2. The Geologic Structure on G/S model

3.2 The petroleum exploration technique on the base of G/S model

In recent years, the petroleum profession software developer has developed the massive office automation software in order to improve the office efficiency, such as the geological cartography software package, reservoir engineering packages, the geological database software package and other related application software package etc., these software play the vital role to improve the level of office automation and efficiency for petroleum vocation. However, the limitation of computer software developing environment makes the inherent insufficiency in graph data management and spatial analysis for various information management system. G/S model provides rich spatial analysis functions, and has a good development interface. To use its powerful functions and its spatial data source in particular petroleum resources management information system, not only can save manpower, lower development costs, moreover manage spatial information related to the graph, image information better.

To use the basic data of G/S model and petroleum field achievement data, is convenient to make thematic maps, also analyze and delineate of hydrocarbon occurrence rules on the ground and gathering places under the guide of geologic and petroleum pool theory. The evaluation of petroleum resources needed multi-sources geology information, in the petroleum field exploration, it plays an important role to proceed comprehensive valuation for potential petroleum resource of somewhere and select favorable area to be systems engineering of supported decision-making for further exploring deploying. How to integrate multi-source data has been a difficult problem to the development of the petroleum field. Most multi-source data relate to the spatial place closely, including storage, covering, combination and transportation of petroleum. Using of G/S model, these data can be exchanged in accordance with the standard and its space-related problem could be also solved well. Therefore, to use its powerful spatial analysis functions, statistical analysis and modeling, such as calculating acreage, interpolation and formed contours, drawing various profiles, buffer analysis, time series analysis, this will provide a powerful support with a more scientific evaluation of petroleum resources.

Petroleum data resources exploring visualization control project is an inevitable development direction, and 3D simulation of basin modeling is an indispensable and important component. G/S model provides the high resolution Digital Elevation Model (DEM) data which can be origin data for simulate terrain.

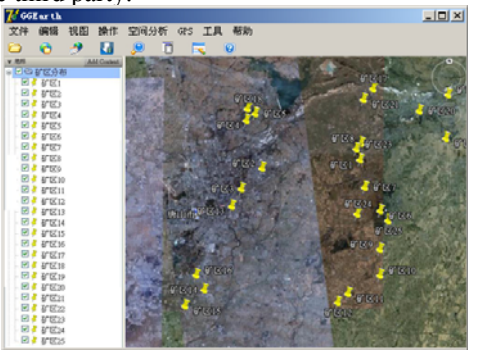
G/S model is a 3D visualization platform to simulate our true earth. Basin simulation as underground space uneven geological body, not only considers its own internal structures, but also analyzes comprehensively with the terrain of neighboring regional environment. The large regional topography data is just the main contents of G/S model. Adding the powerful 3D analysis modeling function of it, the G/S model must be "Digital Petroleum Fields Platform" in the future.

3.3 The petroleum transportation based on G/S model

Storage and transportation of petroleum-gas production is a complex system, it involves a number of factors, Most of elements including pipelines, pressurized facilities, warming facilities, valves, petroleum storage tank are the basic elements to guarantee the safety and effectiveness of transportation and storage. Managers of petroleum-gas storage and transportation must focus on all the above elements to analyze and research, by single-element analyzed to multi-element integrated, finally confirm a way to transport and store petroleum-gas with safety, low-cost and effectively. Petroleum-gas gathering and transportation system optimization program is designed primarily to determine the network topology layout and design parameters, to minimize the investment of system.

GIS functions of Digital Earth Platform consist of acquisition, management, storage, analysis and description of petroleumfield feature attribute and spatial data. To use DEM, Pipelines network design will be more rational and scientific. Petroleum-gas gathering and transportation system based on Digital Earth Platform is the scientific way of dynamic management, it can establish the graphics-base and database for a variety of terra-resource, pipelines, buildings and other facilities, to realize the graphics and database integrated, to complete display, query, zoom of complex terra-resource and pipelines map, and dynamic updates, combined, statistics, analysis and decision support functions for a variety of management data. Furthermore, the other data of G/S model, such as hydrological data, disaster data, ecological data, is an important basis for decision-making of network, it cannot been substituted by the gathering-transportation management system which establish simply by relying on GIS software(figure 3).

To transmit pipeline information, the project information along the pipeline, environment constraint information, landowners information and the information of all these geographically into G/S model, which makes Managers identify geographical features in better accuracy. It also supports more data query of the corresponding geographic area. G/S model with a national basic geographic information system, if integrating local pipelines data, the basic parameters of pipeline (names of operators, pipeline name, size, medium and exist or lost status, data sources etc.), which can implement the accident trend analysis and rapid assessment of the situation pipeline including query of massive pipeline information. This is a great significance to pipeline safety sensitive areas, such as population centers and wildlife protection areas. With the support of 3D visualization on G/S model, the pipeline detailed maps including three-dimensional maps and profiles can be directly made out for the third party to inquiry, it is good settlement to defend the breakage from the third party.



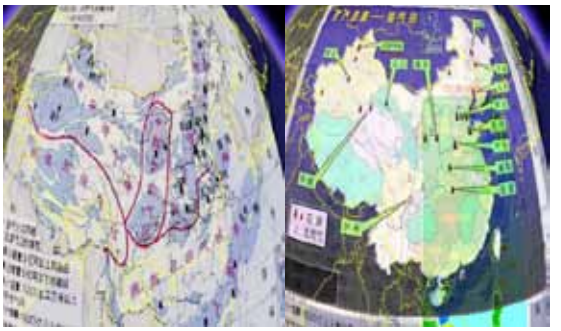


Figure 3. Multi-source data integration show based on G/S model

4. Conclusions

G/S model is an important component and support of Earth Sciences research. It will get a new development opportunity for oil-gas technique by relying on the characteristics including rich industry data of Digital Earth Platform, low-cost, openness, sharing and application, powerful spatial analysis and expression, especially bring its tremendous value in multi-disciplinary, cross-disciplinary, cross-regional research and cooperation ,and the establishment of "Digital Oil-gas Fields ".

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